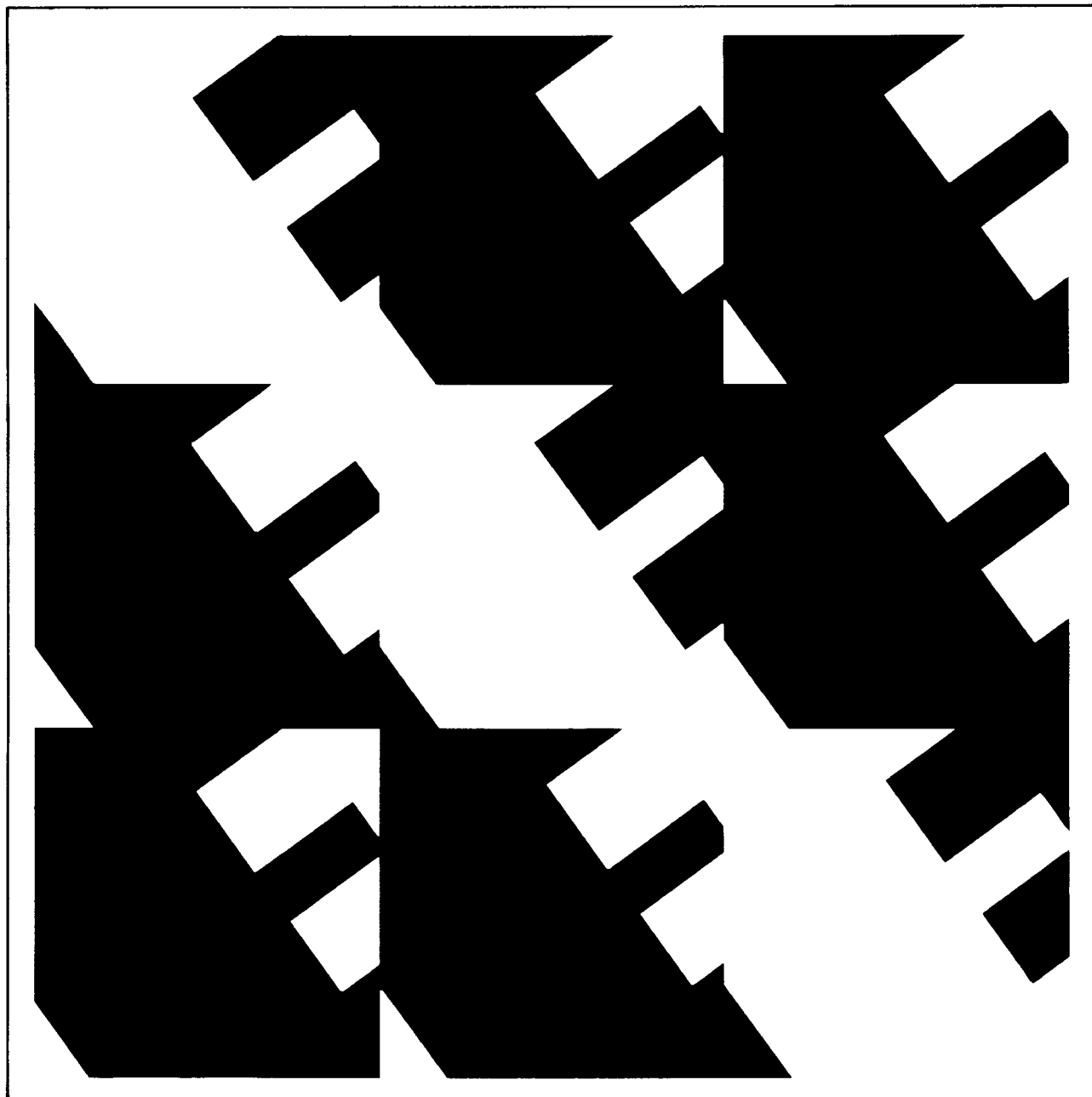


IEEE Standard Glossary of Mathematics of Computing Terminology

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Sponsor
**Standards Coordinating Committee
of the
IEEE Computer Society**

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Foreword

(This Foreword is not a part of ANSI/IEEE Std 1084-1986, IEEE Standard Glossary of Mathematics of Computing Terminology.)

The computer field is continuing to expand. New terms are being generated, and new meanings are being adopted for existing terms. The IEEE Computer Dictionary project was undertaken to document this vocabulary. Its purpose is to identify terms currently in use in the computer field and to establish standard definitions for these terms. The dictionary is intended to serve as a useful reference for those in the computer field and for those who come into contact with computers either through their work or in their everyday lives.

The completed dictionary will contain terms from seven areas: Computer Hardware, Software Engineering, Mathematics of Computing, Theory of Computation, Computer Applications, Computing Methodologies, and the Computing Environment. This increment of the dictionary contains those terms related to the Mathematics of Computing. The remaining six areas will be covered in other increments of the dictionary. All areas will be covered in the overall Computer Dictionary.

Every effort has been made to use definitions from established standards in this dictionary. When existing standards were found to be incomplete, unclear, or inconsistent with other entries in the dictionary, however, new or composite definitions have been developed.

At the time this standard was approved, the following people formed the steering committee of the Computer Dictionary working group:

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An American National Standard

IEEE Standard Glossary of Mathematics of Computing Terminology

1. Scope

This dictionary defines terms in the field of Mathematics of Computing. Topics covered include Boolean algebra, number systems, computer arithmetic, complementation, shifts, arithmetic errors, error detection and correction, number conversions, numeric codes, mathematical notation, and basic mathematics.

Every effort has been made to include all terms in general usage in this field. A term was excluded, however, if it was considered to be:

- (1) Parochial to one particular group or organization
- (2) A company proprietary or trademarked term
- (3) A multi-word term whose meaning could be inferred from definitions of the component words
- (4) A term whose meaning in the computer field could be directly inferred from its standard English meaning

2. Dictionary Structure

Entries in the dictionary are arranged alphabetically. An entry may consist of a single word, such as Boolean, a phrase, such as Boolean algebra, or an abbreviation, such as BCD. Phrases are given in their natural order (Boolean algebra) rather than reversed (algebra, Boolean).

Blanks are taken into account in alphabetizing. They precede all other characters. Hyphens and slashes are treated as blanks. Alternative spellings are shown in parentheses, for example, octad (octade).

A distinction is made between acronyms, which are pronounced as words (for example, ASCII), and other abbreviations which are pronounced as letters (for example, BCD).

If a term has more than one definition, the definitions are listed with numerical prefixes. In general, noun meanings appear first, followed by verb meanings, then adjective meanings, if applicable. This ordering does not imply preference, and the authors have deviated from it when clarity could better be served by a different ordering. Where necessary, examples and notes have been added to clarify the definitions.

The following cross-references are used to show a term's relationship to other terms in the dictionary:

- (1) *Contrast with* refers to a term with an opposite or substantially different meaning.
- (2) *Syn* refers to a synonymous term.
- (3) *See also* refers to a related term.
- (4) *See* refers to a preferred term or to a term whose definition serves to define the term that has been looked up.

The word "deprecated" indicates a term or definition whose use is discouraged because such use is obsolete, misleading, or ambiguous.

3. Sources

In those cases in which a definition is directly quoted from an existing dictionary or glossary, the source is designated in brackets following the definition. Each of these sources granted us permission to use their definitions. A list of all sources used on the Computer Dictionary project is given at the conclusion of the glossary.

4. Definitions for Mathematics of Computing Terms

absolute error. (1) The amount of error expressed in the same units as the quantity containing the error. *Contrast with: relative error.* [67]

(2) Loosely, the absolute value of the error; i.e., the magnitude of the error without regard to its algebraic sign. [67]

absolute value. The magnitude of a quantity without regard to its algebraic sign.

abstract symbol. A symbol whose meaning and use have not been determined by a general agreement but have to be defined for each application of the symbol. [34]

accuracy. A qualitative assessment of correctness, or freedom from error. *Contrast with: precision.*

addend. A number to be added to another number (the augend) to produce a result (the sum).

addition without carry.* *See: exclusive OR.*
*Deprecated.

algebraic manipulation. The processing of mathematical expressions without concern for the numeric values of the symbols that represent numbers. [67]

algorithm. A finite set of well-defined rules for the solution of a problem in a finite number of steps; for example, a complete specification of a sequence of arithmetic operations for evaluating $\sin x$ to a given precision. [67]

American National Standard Code for Information Interchange (ASCII). A binary code in which 128 letters, numbers, and special characters are represented by seven-bit numerals. *Note:* Some systems make use of an eight-bit binary code, called ASCII-8, in which 256 symbols are represented.

ambiguity. A logical expression that has more than one meaning. For example, the expression $A \text{ OR } B \text{ AND } C$ might mean $(A \text{ OR } B) \text{ AND } C$ or $A \text{ OR } (B \text{ AND } C)$ depending upon the rules of interpretation used.

analog. Pertaining to data in the form of continuously variable physical quantities. *Contrast with: digital.*

analog representation. The representation of numerical quantities by means of continuous physical variables such as translation, rotation, voltage, or resistance. *Contrast with: digital representation.*

AND. A Boolean operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the AND of P, Q, R, \dots is true if and only if all statements are true. *Note:* $P \text{ AND } Q$ is often represented by $P \cdot Q$, $P \& Q$, $P \wedge Q$, or PQ . *Syn:* **Boolean multiplication; collation; conjunction; intersection; logic multiply; logical multiply; meet.**

P	Q	$P \wedge Q$
0	0	0
0	1	0
1	0	0
1	1	1

AND truth table

AND-NOT.* *See: exclusion.*
*Deprecated.

arithmetic check. *See: mathematical check.*

arithmetic expression. An expression containing any combination of variables and constants joined by one or more arithmetic operators such that the expression can be reduced to a single numerical result.

arithmetic operation. An operation that is performed in accordance with the rules of ordinary arithmetic.

arithmetic overflow. *See: overflow.*

arithmetic point. *See: radix point.*

arithmetic shift. A shift that affects all digit positions in a register, word, or numeral but does not affect the sign position. For example, +231.702 shifted two places to the left becomes +170.200. *Note:* The result is equivalent to multiplication or division by an integral power of the radix, except for the

truncation effects. *Syn:* **numerical shift**. *Contrast with:* **logical shift**.

arithmetic underflow. *See:* **underflow**.

ASCII. Acronym for **American National Standard Code for Information Interchange**.

assumed binary point. The position in a binary numeral at which the binary point is assumed to be located; usually at the right unless otherwise specified. *Syn:* **implied binary point**.

assumed decimal point. The position in a decimal numeral at which the decimal point is assumed to be located; usually at the right unless otherwise specified. *Syn:* **implied decimal point**.

assumed radix point. The position in a numeral at which the radix point is assumed to be located; usually at the right unless otherwise specified. *Syn:* **implied radix point**.

augend. A number to which another number (the addend) is added to produce a result (the sum).

balanced error. (1) A set of error values in which the maximum and minimum are opposite in sign and equal in magnitude. [61]
(2) A set of error values whose average is zero. *Contrast with:* **unbalanced error**.

base. *See:* **radix**.

base complement. *See:* **radix complement**.

base-minus-one complement. *See:* **diminished-radix complement**.

base notation. *See:* **radix notation**.

base number. *See:* **radix**.

base point. *See:* **radix point**.

BCD. Abbreviation for **binary-coded decimal**.

bias. (1) A systematic deviation of a value from a reference value. [67]
(2) The amount by which the average of a set of values departs from a reference value. *Syn:* **bias error**. [67]

bias error. *See:* **bias** (2).

biased exponent. In floating-point arithmetic, the sum of the exponent and a constant (bias) chosen to make the biased exponent's range nonnegative. [132]

binary. (1) Pertaining to a selection in which there are two possible outcomes.
(2) Pertaining to the numeration system with a radix of two. *Syn:* **natural binary**; **normal binary**; **ordinary binary**; **pure binary**; **regular binary**; **standard binary**; **straight binary**. [1]

binary arithmetic operation. An arithmetic operation in which the operands and the results are represented in the binary numeration system.

binary Boolean operation.* *See:* **dyadic Boolean operation**.
*Deprecated.

binary code. A code that uses exactly two symbolic characters, usually 0 and 1. [1]

binary-coded decimal (BCD). Pertaining to a number representation system in which each decimal digit is represented by a unique arrangement of binary digits (usually four); for example, the number 23 is represented as 0010 0011, whereas in binary notation, 23 is represented as 10111. *Syn:* **coded decimal**. [1]

binary-coded digit. A digit of any number representation system that is represented as a fixed number of binary digits. For example, the decimal digit 9 is represented as 1001.

binary-coded octal. Pertaining to a three-bit binary code in which the octal digits 0–7 are represented by the binary numerals 000–111.

binary digit bit. A numeral used to represent one of the two digits in the binary numeration system; zero (0) or one (1).

binary element. A data element that can assume either of two possible values or states. *See also:* **binary variable**.

binary element string. A string consisting solely of binary elements. [34]

binary incremental representation. An incremental representation system in which the value of an increment is plus one or minus one. *Syn:* **incremental binary representation.**

binary notation. Any notation that uses the binary digits and the radix 2. *Syn:* **binary scale; two-scale.**

binary number. (1) A quantity that is expressed by using the binary numeration system.
(2) Loosely, a binary numeral. [1,67]

binary number system.* *See:* **binary numeration system.**
*Deprecated.

binary numeral. A numeral in the binary numeration system. For example, the binary numeral 101 is equivalent to the decimal numeral 5.

binary numeration system. The numeration system that uses the binary digits and the radix 2. *Syn:* **binary system; pure binary numeration system.**

binary one. The "true" binary state, usually represented as 1 or T. *Contrast with:* **binary zero.**

binary operation.* (1) *See:* **Boolean operation.**
(2) *See:* **dyadic operation.**
*Deprecated.

binary operator. *See:* **dyadic operator.**

binary point. The radix point in the binary numeration system.

binary scale. *See:* **binary notation.**

binary-state variable. *See:* **binary variable.**

binary system. *See:* **binary numeration system.**

binary-to-decimal conversion. The process of converting a binary numeral to an equivalent decimal numeral. For example, binary 10001011.01 is converted to decimal 139.25.

binary-to-hexadecimal conversion. The process of converting a binary numeral to an equivalent hexadecimal numeral. For example, binary 10001011.01 is converted to hexadecimal 8B.4.

binary-to-octal conversion. The process of converting a binary numeral to an equivalent octal numeral. For example, binary 10001011.01 is converted to octal 213.2.

binary variable. A variable that can assume either of two values or logic states: binary zero (false) or binary one (true). *Syn:* **binary-state variable; Boolean variable; two-state variable; two-valued variable.**

binary zero. The "false" binary state, usually represented as 0 or F. *Contrast with:* **binary one.**

biquinary. Pertaining to a two-part representation of decimal digits consisting of a binary portion with values 0 or 5, and a quinary portion with values 0 through 4. For example, the decimal digit 7 is coded as 12, which implies 5 + 2.

biquinary code. A two-part representation of decimal digits consisting of a binary portion with values 0 or 5 and a quinary portion with values 0 through 4. For example, decimal digit 7 is coded as 12.

biquinary-coded decimal. Pertaining to a number representation system in which each decimal digit is represented by a biquinary code.

biquinary notation. Any notation that uses the biquinary code to represent numbers.

biquinary numeration system. A numeration system that alternately uses 2 and 5 as bases. *Note:* The abacus uses a biquinary system.

bit. Acronym for **binary digit.**

block parity. A parity check system capable of detecting and correcting a single error in a binary message. *See also:* **parity check.**

Boolean. Pertaining to the rules of logic for-

ulated by the Irish mathematician George Boole in 1847. [55]

Boolean add. *See:* **OR.**

Boolean algebra. The binary system of algebra formulated by George Boole, dealing with binary variables and employing the basic logical operators AND, OR, NOT, etcetera. *Syn:* **Boolean logic**; **Boolean math.**

Boolean calculus. An extension of Boolean algebra that includes time-dependent operators such as **BEFORE**, **DURING**, **AFTER**.

Boolean complementation. *See:* **NOT.**

Boolean connective. *See:* **Boolean operator.**

Boolean function. A switching function in which the number of possible values of the function and each of its independent variables is two. [34]

Boolean logic. *See:* **Boolean algebra.**

Boolean math. *See:* **Boolean algebra.**

Boolean multiplication. *See:* **AND.**

Boolean operation. Any operation in which each of the operands and the result take one of two values. [34]

Boolean operation table. *See:* **truth table.**

Boolean operator. An operator whose operands and results are binary variables. *Syn:* **Boolean connective.**

Boolean value. The value of a binary variable; either binary zero or binary one.

Boolean variable. *See:* **binary variable.**

borrow. (1) A mathematical process used in subtraction, in which, when the difference in a digit place would be arithmetically negative, the subtraction in that digit place is preceded by increasing the digit in the minuend by the value of the radix, and decreasing the digit in the next higher digit place by one.

(2) The value added to the digit place in (1).

(3) To perform the process defined in (1).

byte. A group of adjacent binary digits operated upon as a unit and usually shorter than a computer word (frequently connotes a group of eight bits). [3]

C. Abbreviation for **centi**.

carry. (1) A mathematical process used in addition and subtraction, in which a value is generated when a sum or product in a digit place exceeds the largest number that can be represented in that digit place, and the value is transferred to the next higher digit place for processing there. *See also:* **cascaded carry**; **complete carry**; **end-around carry**; **half carry**; **high-speed carry**; **partial carry**; **standing-on-nines carry**.

(2) The value generated in (1).

(3) To perform the process defined in (1).

cascaded carry. A carry process in which the addition of two numerals results in a partial-sum numeral and a carry numeral that are in turn added together, this process being repeated until no new carries are generated. *Contrast with:* **high-speed carry**. *See also:* **partial carry**; **partial sum**. [1]

Augend	289594
Addend	320607
First Partial Sum	509191
First Partial Carry	101010
Second Partial Sum	600101
Second Partial Carry	010100
True Sum	610201

Example of cascaded carry

casting out nines. A method of checking addition, subtraction, or multiplication results by dividing decimal values by nine and comparing the remainders. *Syn:* **nines check**.

ceiling. The result obtained by rounding a number up to the nearest integer. For example, the ceiling of 5.3 is 6. *Contrast with:* **floor**.

centi (C). A prefix indicating one hundredth.

chain. A sequence of bits used to construct a binary code. *See also:* **chain code**. [61]

chain code. An arrangement in a cyclic sequence of some or all of the possible different n-bit words in which adjacent words are related such that each word is derivable from

its neighbor by displacing the bits one place to the left or right, dropping the leading bit, and inserting a bit at the end. The value of the inserted bit needs only to meet the requirement that a word must not recur before the cycle is complete. For example, 000 001 010 101 011 111 110 100 000. [1,67,60]

character. A letter, digit, or other symbol that is used to represent information.

character representation system. *See:* **character set.**

character set. The range of characters that is defined for a given system; for example, the 26 letters of the alphabet or the 128 ASCII characters.

characteristic. (1) The integer part of a logarithm. *Contrast with:* **mantissa** (1).
(2) For floating point arithmetic, *see:* **exponent** (2).

characteristic overflow. *See:* **exponent overflow.**

characteristic underflow. *See:* **exponent underflow.**

check bit. A binary check digit. For example, a parity bit. [1]

check digit. One of a set of redundant digits in a word, byte, character, or message that depends upon the remaining digits in such a fashion that if a digit changes, the error can be detected.

check sum. A sum obtained by adding the digits in a numeral, or group of numerals, usually without regard to meaning, position, or significance. This sum may be compared with a previously computed value to verify that no errors have occurred. *Syn:* **hash total.** *See also:* **sideways sum; summation check.**

Chinese binary. *See:* **column binary.**

circular shift. A variation of a logical shift in which the digits moved out of one end of a register, word, or numeral are returned at the other end. For example, +231.702 shifted two places to the left becomes 3170.2+2. *Note:* A

circular shift may be applied to the multiple precision representation of a number. *Syn:* **cyclic shift; end-around shift; end-around carry shift; ring shift; rotate.**

code. (1) The set of rules used to convert data from one form of representation to another.
(2) Data that have been expressed in symbolic form.
(3) To represent data in symbolic form.

code distance. *See:* **Hamming distance.**

code set. The complete set of representations defined by a code. For example, all of the three-letter international designations for airports.

coded decimal. *See:* **binary-coded decimal.**

collate. To compare and merge two or more similarly ordered or sequenced sets into one ordered set. For example, to arrange the set 1, 4, 9, 12, 18 and the set 2, 5, 10, 19 as the single set 1, 2, 4, 5, 9, 10, 12, 18, 19. [61]

collation. *See:* **AND.**

column binary. Pertaining to the binary representation of data in which adjacent positions in a column correspond to adjacent binary digits. For example, each column in a 12-row card may be used to represent 12 consecutive bits of a binary word. *Syn:* **Chinese binary.** *Contrast with:* **row binary.**

column split. The capability of a punch card device to read or punch two parts of a card column independently. [67]

compare. To examine a quantity for the purpose of determining its relationship to zero, or to examine two quantities for the purpose of determining equality or relative magnitude.

complement. A numeral derived from a given numeral by a specified subtraction rule. Often used to represent the negative of the number represented by the given numeral. *See also:* **radix complement; diminished-radix complement.**

complement base. The numeral from which a

- given numeral is subtracted to obtain its complement.
- complement on n.** *See:* **radix complement.**
- complement on n-1.** *See:* **diminished-radix complement.**
- complement on nine.** *See:* **nines complement.**
- complement on one.** *See:* **ones complement.**
- complement on ten.** *See:* **tens complement.**
- complement on two.** *See:* **twos complement.**
- complementary operation.** Two Boolean operations are complementary if the result of one operation is the negation of the result of the other, for all combinations of operands. For example, the AND and NAND operations are complementary. *Contrast with:* **dual operation.**
- complementary operator.** *See:* **NOT.**
- complementation.** The process of obtaining a complement.
- complemented representation.** A positional notation system in which negative numbers are represented by their complements and positive numbers are represented in their usual form. *See also:* **twos-complement notation.**
- complete carry.** A carry process in which the carry digits are transferred and processed as they occur. *Contrast with:* **partial carry.**
- complex number.** A number consisting of a real part (a) and an imaginary part (b), expressed in the form $a + bi$, where $i^2 = -1$.
- computer word.** *See:* **word.**
- conditional implication.** *See:* **implication.**
- conjunction.** *See:* **AND.**
- continuous-progression code.** *See:* **unit-distance code.**
- correction.** A quantity (equal in absolute value to the error) added to a calculated or observed value to obtain the true value. [60]
- cross check.** To test for accuracy by comparing the results of two different methods of computation.
- cyclic binary code.** *See:* **Gray code.**
- cyclic code.** *See:* **Gray code.**
- cyclic decimal code.** A binary code in which sequential decimal digits are represented by four-bit BCD expressions, each of which differs from the preceding expression in one place only. *Note:* This is an example of unit-distance code.
- cyclic permuted code.** *See:* **unit-distance code.**
- cyclic shift.** *See:* **circular shift.**
- deca (deka).** A prefix indicating ten.
- deci.** A prefix indicating one tenth.
- decimal.** (1) Pertaining to a selection in which there are ten possible outcomes.
(2) Pertaining to the numeration system with a radix of ten. *Syn:* **denary.**
- decimal digit.** A numeral used to represent one of the ten digits in the decimal numeration system; 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9.
- decimal notation.** Any notation that uses the decimal digits and the radix 10.
- decimal number.** (1) A quantity that is expressed using the decimal numeration system.
(2) Loosely, a decimal numeral.
- decimal number system.*** *See:* **decimal numeration system.**
*Deprecated.
- decimal numeral.** A numeral in the decimal numeration system. For example, the decimal numeral 12 is equivalent to the Roman numeral XII.
- decimal numeration system.** The numeration system that uses the decimal digits and the radix 10. *Syn:* **decimal system.**

decimal point. The radix point in the decimal numeration system. [67]

decimal system. *See:* **decimal numeration system.**

decimal-coded digit. A digit or character defined by a set of decimal digits, such as a pair of decimal digits specifying a letter or special character in a system of notation. [59,60]

decimal-to-BCD conversion. The process of converting a decimal numeral to an equivalent BCD numeral. For example, decimal 139 is converted to BCD 1 0011 1001.

decimal-to-binary conversion. The process of converting a decimal numeral to an equivalent binary numeral. For example, decimal 139.25 is converted to binary 10001011.01.

decimal-to-hexadecimal conversion. The process of converting a decimal numeral to an equivalent hexadecimal numeral. For example, decimal 139.25 is converted to hexadecimal 8B.4.

decimal-to-octal conversion. The process of converting a decimal numeral to an equivalent octal numeral. For example, decimal 139.25 is converted to octal 213.2.

decrement. (1) The quantity by which a variable is decreased.

(2) To decrease the value of a variable. *Contrast with:* **increment** (2).

(3) To decrease the value of a variable by one. *Contrast with:* **increment** (3).

deka. *See:* **deca.**

denary. *See:* **decimal** (2).

denormalized number. A nonzero floating-point number whose exponent has a reserved value, usually the format's minimum, and whose explicit or implicit significand digit is zero.

dense binary code. A binary code in which all possible bit combinations are used.

designation number. In logic design, the bottom line of a truth table written such that the

values of the variables equal the binary number of the state. For example, the designation number for a two-variable exclusive-OR function is as follows:

State	0 1 2 3
Variable A	0 1 0 1
Variable B	0 0 1 1
Exclusive OR	0 1 1 0 (Designation number)

[55]

destination. The location for the result of a binary or unary operation. [132]

destructive addition. Computer addition in which the sum is placed in the storage location, register, or accumulator previously occupied by an operand, usually the augend, which is then lost. *Contrast with:* **nondestructive addition.**

diad. A group of two closely related items or digits.

dichotomy. A division into two classes that are mutually exclusive and dual in nature. For example, all zero and all nonzero, or all true and all false. [61]

difference. The result of a subtraction operation.

digit. A character used to represent one of the non-negative integers smaller than the radix. For example, in decimal notation, one of the characters 0 to 9. *Syn:* **numeric character.**

digit place. (1) In a positional notation system, a position corresponding to a given power of the radix.

(2) A location in which a digit may occur in a numeral. *Syn:* **digit position; place; position; symbol rank.**

digit position. *See:* **digit place.**

digital. Pertaining to quantities in the form of discrete, integral values. *Contrast with:* **analog.**

digital representation. The representation of numerical quantities by means of digits, or discrete values. *Contrast with:* **analog representation.**

digital variable.* (1) *See: binary variable.*
(2) *See: integer variable.*
*Deprecated

digitization. Conversion of analog data to digital data.

digitize. To express analog data in digital form.

diminished-radix complement. The complement obtained by subtracting each digit of a given numeral from the largest digit in the numeration system. For example, ones complement in binary notation, nines complement in decimal notation. *Syn: radix-minus one complement; base-minus-one complement; complement on n-1. Contrast with: radix complement.*

directed rounding. The process of approximating an exact value by a digital numeral such that the resulting error is known to be either non-positive or non-negative. The resulting number is therefore guaranteed to be an upper or lower bound.

disjunction. *See: OR.*

divide check. An indicator that denotes that an invalid division has been attempted or has occurred. [60]

dividend. A number to be divided by another number (the divisor) to produce a result (the quotient), and perhaps a remainder.

divisor. A number by which another number (the dividend) is divided to produce a result (the quotient), and perhaps a remainder.

double length. *See: double precision.*

double precision. Pertaining to the use of two computer words to represent a number in order to preserve or gain precision. *Syn: double length.* [1]

double-precision addition. Computer addition performed with operands that are expressed in double-precision representation.

double-precision arithmetic. Computer arithmetic performed with operands that are expressed in double-precision representation.

doublet. A group of two adjacent digits operated upon as a unit.

dual operation. Two Boolean operations are dual if the result of one operation is the negation of the result of applying the other operation to the negated operands, for all combinations of operands. For example, the AND and NOR operations are dual operations. *Contrast with: complementary operation.*

duodecimal. (1) Pertaining to a selection in which there are 12 possible outcomes.
(2) Pertaining to the numeration system with a radix of 12. [1]

duosexadecimal. (1) Pertaining to a selection in which there are 32 possible outcomes.
(2) Pertaining to the numeration system with a radix of 32. *Syn: duotricenary.*

duotricenary. *See: duosexadecimal.*

dyadic. Pertaining to an operation involving two operands. *Contrast with: monadic.*

dyadic Boolean operation. A logical operation involving two operands. For example, the equivalence operation. *Contrast with: monadic Boolean operation.*

dyadic operation. An operation involving two operands. *Contrast with: monadic operation.* [1]

dyadic operator. An operator that specifies an operation on two operands. *Syn: binary operator. Contrast with: monadic operator.*

EBCDIC. Acronym for extended binary-coded decimal interchange code.

EITHER-OR.* *See: OR.*
*Deprecated.

end-around carry. A carry process in which a carry digit generated in the most significant digit place is added directly to the least significant digit place. For example, when adding two negative numbers using nines complement.

end-around-carry shift. *See: circular shift.*

end-around shift. *See:* **circular shift.**

equivalence. A dyadic Boolean operator having the property that if P is a statement and Q is a statement, then the equivalence of P and Q is true if and only if both statements are true or both statements are false. *Note:* The equivalence of P and Q is often represented by $P \equiv Q$. *Syn:* **exclusive NOR; IF-AND-ONLY-IF.**

P	Q	$P \equiv Q$
0	0	1
0	1	0
1	0	0
1	1	1

Equivalence truth table

equivalent binary digit factor. *See:* **equivalent binary digits.**

equivalent binary digit(s). The number of binary digits required to represent a number expressed in another numeration system with no loss of precision. *Note:* This number is approximately $3\frac{1}{2}$ times the number of decimal digits. *Syn:* **equivalent binary digit factor.**

error burst. A group of bits in which two erroneous bits are separated by fewer than a specified number of correct bits.

error-correcting code. A code containing redundant information that can be used to detect certain classes of errors and to restore a word, byte, character, quantity, or message to its correct representation. *Syn:* **error-detecting and correcting code.**

error-detecting and correcting code. *See:* **error-correcting code.**

error-detecting code. A code containing redundant information that can be used to detect certain classes of errors in a word, byte, character, quantity, or message. *Syn:* **self-checking code.**

even-odd check. *See:* **parity check.**

even parity. (1) An error detection method in which the number of ones in a binary word, byte, character, or message is maintained as

an even number.

(2) The property possessed by a binary word, byte, character, or message that has an even number of ones.

except operation.* *See:* **exclusion.**
*Deprecated.

excess-fifty code. A binary code in which a decimal number n is represented by the binary equivalent of $n+50$. *Syn:* **excess-fifty representation.**

excess-fifty representation. *See:* **excess-fifty code.**

excess-sixty-four code. A binary code in which a decimal number n is represented by the binary equivalent of $n+64$. *Syn:* **excess-sixty-four representation.**

excess-sixty-four representation. *See:* **excess-sixty-four code.**

excess-three BCD. *See:* **excess-three code.**

excess-three code. A BCD code in which a decimal digit n is represented by the four-bit binary equivalent of $n+3$. *Syn:* **excess-three BCD; excess-three representation.**

DECIMAL DIGIT:	0	1	2	3
EXCESS 3 CODE:	0011	0100	0101	0110

Excess-three code

excess-three representation. *See:* **excess-three code.**

exclusion. A dyadic Boolean operator having the property that if P is a statement and Q is a statement, then the expression P exclusion Q is true if and only if P is true and Q is false. *Note:* P exclusion Q is often represented by a combination of AND and NOT symbols such as $P \wedge \sim Q$. *Syn:* **NOT-IF-THEN.**

P	Q	$P \wedge \sim Q$
0	0	0
0	1	0
1	0	1
1	1	0

Exclusion truth table

exclusive NOR (XNOR). *See:* equivalence.

exclusive OR (XOR). A dyadic Boolean operator having the property that if P is a statement and Q is a statement, then P exclusive-OR Q is true if and only if either, but not both, is true. *Note:* P exclusive OR Q is often represented by $P \oplus Q$ or $P \vee Q$. *Syn:* nonequivalence; inequivalence; modulo-two sum. *Contrast with:* OR.

\overline{P}	\overline{Q}	$\overline{P \oplus Q}$
0	0	0
0	1	1
1	0	1
1	1	1

Exclusive OR truth table

exponent. (1) A superscript indicating the number of times a number is to be used as a factor. (2) The component of a floating-point number that normally signifies the integer power to which the radix is raised in determining the value of the represented number. *Syn:* characteristic; exrad; floating-point coefficient. *Contrast with:* significand. [125]

exponent overflow. A condition that occurs in floating-point arithmetic if an attempt is made to create an exponent greater than the largest positive number that can be processed or stored. *Syn:* characteristic overflow.

exponent spill. A condition that occurs in floating-point arithmetic when the exponent of a computed result lies outside the range that can be processed or stored.

exponent underflow. A condition that occurs in floating-point arithmetic if an attempt is made to create a negative exponent greater in absolute value than the smallest nonzero number that can be processed or stored. *Syn:* characteristic underflow.

expression. A sequence of constants, variables, and functions connected by operators to indicate a desired computation.

exrad. *See:* exponent (2).

extended binary-coded-decimal interchange code (EBCDIC). A binary code in which 256 letters, numbers, and special characters are represented by eight-bit numerals.

extended precision. *See:* multiple precision.

factor. (1) Any of the operands in a multiplication operation.

(2) A number used as a multiplier to cause a set of quantities to fall within a given range of values. *Syn:* factor scale.

factor scale. *See:* factor (2).

false add. *See:* OR.

Fibonacci number. An integer in the Fibonacci series. [2]

Fibonacci series. A series of integers formulated by the Italian mathematician Leonardo Fibonacci, in which each integer is equal to the sum of the two preceding integers in the series, that is, 0, 1, 1, 2, 3, 5, 8, 13, 21. . . . Represented mathematically by

$$x_i = x_{i-1} + x_{i-2}$$

where

$$x_0 = 0$$

$$x_1 = 1$$

fix. To convert a number from floating-point representation to fixed-point representation. *Contrast with:* float.

fixed point. Pertaining to a numeration system in which the position of the radix point is fixed with respect to one end of the numerals, according to some convention. *Contrast with:* floating point; variable point. [1]

fixed-point arithmetic. A method of arithmetic in which the numbers are expressed in the fixed-point representation system. *Contrast with:* floating-point arithmetic.

fixed-point number. A number expressed in fixed-point representation.

fixed-point part. *See:* significand.

fixed-point representation system. A numeration system in which the position of the radix

point is fixed with respect to one end of the numerals, according to some convention.

fixed-radix notation. A radix notation system in which all digit positions have the same radix. The weights of successive digit places are successive integral powers of a single radix. *Syn:* **fixed-radix numeration system**; **fixed-radix scale**.

fixed-radix numeration system. *See:* **fixed-radix notation**.

fixed-radix scale. *See:* **fixed-radix notation**.

float. To convert a number from fixed-point representation to floating-point representation. *Contrast with:* **fix**.

floating character. A character placed in the position that is one place more significant than the otherwise most significant position. [61]

floating decimal.* *See:* **floating point**.
*Deprecated.

floating point. Pertaining to a numeration system in which each number is represented as a fractional quantity multiplied by an integral power of the radix. *Contrast with:* **fixed point**; **variable point**.

floating-point arithmetic. A method of arithmetic in which the numbers are expressed in the floating-point representation system. *Contrast with:* **fixed-point arithmetic**.

floating-point coding compaction. A method of numerical data compaction that uses the floating-point representation system.

floating-point coefficient. *See:* **exponent** (2).

floating-point number. A digit string characterized by three components: a sign, a signed exponent, and a significand. Its numerical value, if any, is the signed product of its significand and the radix raised to the power of its exponent. [125]

floating-point representation system. A numeration system in which each number is represented as a sign, a signed exponent, and a significand, where the numerical value, if any,

is the signed product of its significand and the radix raised to the power of the exponent.

floor. The result obtained by rounding a number down to the nearest integer. For example, the floor of 5.3 is 5. *Contrast with:* **ceiling**.

fraction. In floating point arithmetic, the component of the significand that lies to the right of its implied radix point.

fractional binary. Pertaining to a binary numeral with the binary point (expressed or implied) at the left end, representing a fraction.

fractional fixed point. Pertaining to fixed-point numeration system in which each number is represented by a numeral with the radix point (expressed or implied) at the left end. All numbers greater than or equal to one must be scaled accordingly.

G. Abbreviation for **giga**.

generated error. The total error resulting from the combined effects of using imprecise arguments in an inexact formula. For example, using a rounded number in a truncated series.

giga (G). A prefix indicating one billion (10^9).

Gray code. A binary code in which sequential numbers are represented by binary expressions, each of which differs from the preceding expression in one place only. *Syn:* **cyclic binary code**; **cyclic code**; **reflected code**; **reflected-binary code**; **reflected-binary unit-distance code**. [67]

DECIMAL DIGIT:	0	1	2	3	4	5
GRAY CODE:	000	001	011	010	110	111

Example of a Gray code

half-adjust. To round a number by changing the least significant digit to zero and adding one to the next digit if the value of the least significant digit was half the radix or greater.

half carry. A carry process in which a carry digit generated in the most significant digit place of the less-significant half of a sum is transferred to the least significant digit place of the more significant half.

Hamming code. Any of several error-correcting codes invented by the mathematician Richard Hamming, which use redundant information bits to detect and correct any single error in a transmitted character. *See also:* **error-correcting code**.

Hamming distance. The number of digit positions in which two binary numerals, characters, or words of the same length are different. For example, the Hamming distance between 100101 and 101001 is two. *Syn:* **code distance**; **signal distance**.

hash total. *See:* **check sum**.

hex. Acronym for **hexadecimal**.

hexadecimal. (1) Pertaining to a selection in which there are sixteen possible outcomes. [1]
(2) Pertaining to the numeration system with a radix of 16. *Syn:* **sexadecimal**.

hexadecimal digit. A numeral used to represent one of the 16 digits in the hexadecimal numeration system; 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, or F.

hexadecimal notation. Any notation that uses the hexadecimal digits and the radix 16.

hexadecimal number. (1) A quantity that is expressed using the hexadecimal numeration system.
(2) Loosely, a hexadecimal numeral.

hexadecimal number system.* *See:* **hexadecimal numeration system**.
*Deprecated.

hexadecimal numeral. A numeral in the hexadecimal numeration system. For example, the hexadecimal numeral 17 is equivalent to the decimal numeral 23.

hexadecimal numeration system. The numeration system that uses the hexadecimal digits and the radix 16. *Syn:* **hexadecimal system**.

hexadecimal point. The radix point in the hexadecimal numeration system.

hexadecimal system. *See:* **hexadecimal numeration system**.

hexadecimal-to-decimal conversion. The process of converting a hexadecimal numeral to an equivalent decimal numeral. For example, hexadecimal 8B.4 is converted to decimal 139.25.

high-order. Pertaining to the left-most digit or digits of a numeral.

high-speed carry. A carry process in which if the current sum in a given digit place is one less than the base, the sum is set to zero and the carry input is passed to the next place. *Contrast with:* **cascaded carry**. *See also:* **standing-on-nines carry**.

identity operation. A Boolean operation whose result is true if and only if the operands are all true or all false. *Note:* An identity operation on two operands is the same as an equivalence operation.

IF-AND-ONLY-IF. *See:* **equivalence**.

IF-THEN. *See:* **implication**.

implication. A dyadic Boolean operator having the property that if P is a statement and Q is a statement, then the expression "P implies Q" is true in all cases except when P is true and Q is false. *Note:* P implies Q is often represented as $P \rightarrow Q$. *Syn:* **conditional implication**; **IF-THEN**.

P	Q	$P \rightarrow Q$
0	0	1
0	1	1
1	0	0
1	1	1

Implication truth table

implied binary point. *See:* **assumed binary point**.

implied decimal point. *See:* **assumed decimal point**.

implied radix point. *See:* **assumed radix point**.

inclusion.* *See:* **implication**.
*Deprecated.

inclusive OR. *See:* **OR.**

increment. (1) The quantity by which a variable is increased.

(2) To increase the value of a variable. *Contrast with:* **decrement** (2).

(3) To increase the value of a variable by one. *Contrast with:* **decrement** (3).

incremental binary representation. *See:* **binary incremental representation.**

incremental representation. Any number representation system in which the numerals express changes in the variables rather than the variables themselves. *See also:* **binary incremental representation**; **ternary incremental representation.**

incremental ternary representation. *See:* **ternary incremental representation.**

inequivalence. *See:* **exclusive OR.**

infix notation. A method of forming mathematical expressions in which each operator is written between its operands and the expression is interpreted subject to rules of operator precedence and grouping symbols. For example, A added to B and the result multiplied by C is represented as $(A + B) \cdot C$. *Contrast with:* **postfix notation**; **prefix notation.**

inherent error. *See:* **inherited error.**

inherited error. An error that is input to a given operation, either from a previous operation or from the initial condition of a variable. *Syn:* **inherent error.** *Contrast with:* **propagated error.**

integer. A positive or negative whole number, including zero. *Syn:* **integral number.**

integer arithmetic. Fixed-point arithmetic in which the radix point is assumed to lie immediately to the right of the least significant digit in each numeral; that is, all numbers are assumed to be integers.

integer variable. A variable that may assume only integer (non-fractional) values.

integral number. *See:* **integer.**

intermediate product. *See:* **partial product.**

intersection. *See:* **AND.**

inverse. *See:* **ones complement.**

inverse binary state. *See:* **ones complement.**

inversion. (1) In Boolean algebra, the same as NOT.

(2) The process of taking the reciprocal of a number.

invert. (1) To change a binary variable to its opposite logic state.

(2) To take the reciprocal of a number.

justify. To shift a numeral so that the most significant digit, the least significant digit, or the radix point is placed at a specific position in a register.

K. Abbreviation for kilo.

Karnaugh map. A rectangular diagram of a logical expression drawn with overlapping rectangles representing a unique combination of the logic variables and such that an intersection is shown for all combinations. The rows and columns are headed with combinations of the variables in a Gray code sequence. *See also:* **logic map**; **Mahoney map.**

kilo (K). (1) A prefix indicating one thousand.
(2) In statements involving size of computer storage, a prefix indicating 2^{10} , or 1024.

Kordic algorithm. A widely used algorithm that calculates the sine and cosine of an angle using only addition, subtraction, and shifting operations in scaled arithmetic. [55]

least significant bit (LSB). The bit having the smallest effect on the value of a binary numeral; usually the rightmost bit.

least significant digit. The digit having the smallest effect on the value of a numeral; usually the rightmost digit.

linear programming. The analysis or solution of problems in which a linear function of a number of variables is to be maximized or minimized, when those variables are subject

to constraints in the form of linear inequalities.

logic add. *See:* **OR.**

logic comparison. *See:* **logical comparison.**

logic decision. *See:* **logical comparison.**

logic diagram. A graphical representation of a system's logic elements and their interconnections. *Syn:* **logical diagram.**

logic difference. *See:* **logical difference.**

logic function.* *See:* **switching function.**
*Deprecated.

logic map. A worksheet used by logic designers in the process of logic development, simplification, or optimization. *See also:* **Karnaugh map; Mahoney map.**

logic multiply. *See:* **AND.**

logic operation. *See:* **logical operation.**

logic operator. *See:* **logical operator.**

logic product. *See:* **logical product.**

logic shift. *See:* **logical shift.**

logic state. One of the two possible values a binary variable may assume.

logic sum. *See:* **logical sum.**

logic symbol. (1) A symbol used to denote a logical operator.
(2) A symbol used to graphically represent a logic element. *Syn:* **logical symbol.** [60]

logic variable.* *See:* **switching variable.**
*Deprecated.

logical add. *See:* **OR.**

logical comparison. The examination of two binary variables to determine whether they have the same value. *Syn:* **logic comparison; logic decision; logical decision.**

logical connective. *See:* **logical operator.**

logical decision. *See:* **logical comparison.**

logical diagram. *See:* **logic diagram.**

logical difference. A set consisting of all elements belonging to set A but not to set B, when two sets of elements, A and B, are given. *Syn:* **logic difference.**

logical expression. A combination of symbols and variables representing a logical relationship. [55]

logical multiply. *See:* **AND.**

logical operation. (1) An operation involving logical variables and operators.
(2) Loosely, any nonarithmetic computer operation. *Syn:* **logic operation.**

logical operator. A symbol that represents a logical operation to be performed on the associated operands. *Syn:* **logic operator; logical connective.**

logical product. The result obtained from the AND operation. *Syn:* **logic product.** [61]

logical shift. A shift that affects all positions in a register, word, or numeral, including the sign position. For example, +231.702 shifted two places to the left becomes 3170.200. *Note:* A logical shift may be applied to the multiple-precision representation of a number. *Syn:* **logic shift; nonarithmetic shift.** *Contrast with:* **arithmetic shift.**

logical sum. The result obtained from the OR operation. *Syn:* **logic sum.**

logical symbol. *See:* **logic symbol.**

logical variable. *See:* **switching variable.**

look-up table. A table of values used in obtaining the value of a function using a table look-up procedure.

low-order. Pertaining to the right-most digit or digits of a numeral.

LSB. Abbreviation for **least significant bit.**

Lukasiewicz notation. *See:* **prefix notation.**

m. Abbreviation for **milli**.

M. Abbreviation for **mega**.

m-out-of-n code. A binary code in which *m* of the *n* digits that represent a word, character, or digit are in one state, and the other digits are in the opposite state. *See also:* **two-out-of-five code**.

machine word. *See:* **word**.

Mahoney map. A diagram used in logic design, simplification, or optimization; invented by Matthew V. Mahoney. *See also:* **Karnaugh map**; **logic map**. [55]

majority. A Boolean operator having the property that if *P* is a statement, *Q* is a statement, *R* is a statement,..., then the majority of *P, Q, R, ...* is true if more than half the statements are true, false if half or less are true.

mantissa. (1) The fractional part of a logarithm. *Contrast with:* **characteristic** (1). [60]
(2) For floating-point arithmetic, *see:* **significand**.

Markov chain. A probabilistic model of events in which the probability of an event is dependent only on the event that precedes it. [67]

mathematical check. A check of the accuracy of a calculation by performing additional calculations. For example, verification of multiplication results by dividing the product by the multiplier to obtain the multiplicand. *Syn:* **arithmetic check**.

mega (M). (1) A prefix indicating one million.
(2) In statements involving size of computer storage, a prefix indicating 2^{20} , or 1,048,576.

micro (μ). A prefix indicating one millionth.

milli (m). A prefix indicating one thousandth.

meet. *See:* **AND**.

minimum-distance code. A BCD code in which the Hamming distance between consecutive numerals does not fall below a specified minimum value.

minuend. A number from which another number (the subtrahend) is subtracted to produce a result (the difference).

mixed-base notation. *See:* **mixed-radix notation**.

mixed-base numeration system. *See:* **mixed-radix notation**.

mixed-radix notation. A radix notation system in which all digit positions do not have the same radix. For example, biquinary notation in which the digit positions have the radix 2 or 5, alternately. *Syn:* **mixed-base notation**; **mixed-base numeration system**; **mixed-radix numeration system**. *Contrast with:* **fixed-radix notation**.

mixed-radix numeration system. *See:* **mixed-radix notation**.

mod. Acronym for **modulo**.

mode. A variable that a user may set, sense, save, and restore to control the execution of subsequent arithmetic operations. [132]

modulo (mod). An arithmetic operation that yields the remainder of an integer division problem. For example, $39 \equiv 3$ modulo 6.

modulo-n counter. A counter that reverts to zero in the counting sequence after reaching a value of *n*-1.

modulo-n residue. The remainder obtained by dividing a number by *n*.

modulo-two sum. *See:* **exclusive OR**.

modulus. The number of integers that can be represented in a numeration system. For example, in a system with a modulus of five, the only integers that can be represented are 0, 1, 2, 3, and 4.

monadic. Pertaining to an operation involving a single operand. *Contrast with:* **dyadic**. [55]

monadic Boolean operation. A logical operation involving one operand. For example, the NOT operation. *Contrast with:* **dyadic Boolean operation**.

monadic operation. An operation involving one operand. For example, the square root operation. *Syn:* **unary operation**. *Contrast with:* **dyadic operation**.

monadic operator. An operator that specifies an operation on one operand. For example, the square root operator. *Syn:* **unary operator**. *Contrast with:* **dyadic operator**.

Monte Carlo method. Any procedure that involves statistical sampling techniques to obtain an approximate solution to a mathematical or physical problem.

most significant bit (MSB). The bit having the greatest effect on the value of a binary numeral; usually the leftmost bit.

most significant digit. The digit having the greatest effect on the value of a numeral; usually the leftmost digit.

moving average. An average calculated on a selected, changing subset of a time series of data. For example, a four-point moving average would be the average of the last four data points in the time series.

MSB. Abbreviation for **most significant bit**.

multiple arithmetic. A system or method of performing ordinary arithmetic with a digital computer where several parts of one or more numbers are utilized in an arithmetic operation, yielding several results. [61]

multiple precision. Pertaining to the use of two or more computer words to represent a number in order to preserve or gain precision. *Syn:* **extended precision**; **multiprecision**. *See also:* **double precision**; **triple precision**.

multiple-precision arithmetic. Computer arithmetic performed with operands that are expressed in multiple-precision representation.

multiplicand. A number to be multiplied by another number (the multiplier) to produce a result (the product).

multiplier. A number by which another number

(the multiplicand) is multiplied to produce a result (the product).

multiprecision. *See:* **multiple precision**.

n-adic. *See:* **n-ary**.

n-adic Boolean operation. A Boolean operation involving exactly n operands. *Syn:* **n-ary Boolean operation**. *See also:* **dyadic Boolean operation**; **monadic Boolean operation**.

n-adic operation. An operation involving exactly n operands. *Syn:* **n-ary operation**. *See also:* **dyadic operation**; **monadic operation**.

n-ary. (1) Pertaining to a selection in which there are n possible outcomes.
(2) Pertaining to a numeration system with a radix of n . *Syn:* **n-adic**.

n-ary Boolean operation.* *See:* **n-adic Boolean operation**.

*Deprecated.

n-ary operation. *See:* **n-adic operation**.

n-bit byte. A group of n adjacent binary digits operated upon as a unit.

n-tuple. A collection of n elements, usually ordered. For example, $x_1, x_2, x_3, \dots, x_n$.

NaN. Acronym for not a number; a symbolic entity encoded in floating-point format.

NAND. A Boolean operator having the property that if P is a statement, Q is a statement, R is a statement, ..., then the NAND of P, Q, R, \dots is true if and only if at least one statement is false. *Note:* The NAND of P and Q is often represented by \overline{PQ} . *Syn:* **nonconjunction**; **Sheffer stroke**.

\overline{P}	\overline{Q}	\overline{PQ}
0	0	1
0	1	1
1	0	1
1	1	0

NAND truth table

natural binary. *See:* **binary**.

natural number. (1) A non-negative integer.
(2) Occasionally, any positive integer.

negate. To perform the NOT operation.

negation. *See:* NOT.

NEITHER-NOR.* *See:* NOR.
*Deprecated.

nibble (nybble). *See:* quartet.

nines check. *See:* casting out nines.

nines complement. The diminished-radix complement of a decimal numeral, which is formed by subtracting each digit from 9. For example, the nines complement of 4830 is 5169. *Syn:* complement on nine.

nonarithmetic shift. *See:* logical shift.

nonconjunction. *See:* NAND.

nondestructive addition. Addition performed on a computer in such a manner that the first operand placed in the arithmetic register is the augend. The addend is then added, and the sum becomes the new augend. *Contrast with:* destructive addition. [61]

nondisjunction. *See:* NOR.

nonequivalence. *See:* exclusive OR.

nonidentity operation. A Boolean operation whose result is true if and only if not all of the operands have the same Boolean value. *Note:* A nonidentity operation on two operands is the same as an exclusive-OR operation.

NOR. A Boolean operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the NOR of P,Q,R,... is true if and only if all statements are false. *Note:* P NOR Q is often represented by $P \downarrow Q$. *Syn:* nondisjunction.

\overline{P}	\overline{Q}	$\overline{P \downarrow Q}$
0	0	1
0	1	0
1	0	0
1	1	0

NOR truth table

normal binary. *See:* binary.

normal number. A non-zero number that is finite and not subnormal. [125]

normal random number. Any member of a random number sequence that has a normal, or Gaussian, distribution.

normalize. To shift the fixed-point part of a floating-point number, and make the corresponding adjustment to the exponent, to ensure that the fixed-point part lies within some prescribed range. The number represented remains unchanged. *Syn:* standardize.

NOT. A monadic Boolean operator having the property that if P is a statement, then the expression "NOT P" is true if P is false, and false if P is true. *Note:* NOT P is often represented by $\sim P$, \overline{P} , or P' . *Syn:* Boolean complementation; complementary operator; inversion (1); negation.

\overline{P}	$\overline{\overline{P}}$
0	1
1	0

NOT truth table

NOT-AND.* *See:* NAND.
*Deprecated.

NOT-BOTH.* *See:* NAND.
*Deprecated.

NOT-IF-THEN. *See:* exclusion.

NOT-OR.* *See:* NOR.
*Deprecated

notation. A system of symbols used to represent information, and the rules for their use.

noughts complement. *See:* radix complement.

novenary. (1) Pertaining to a selection in which there are nine possible outcomes.
(2) Pertaining to the numeration system with a radix of 9.

novendenary. (1) Pertaining to a selection in

which there are 19 possible outcomes.

(2) Pertaining to the numeration system with a radix of 19.

number. (1) A mathematical abstraction indicating a quantity or amount.

(2) Loosely, a numeral. [67,61]

number range. The set of values that a number may assume.

number representation. A representation of a number in a numeration system. *Syn:* **numeration.** [34]

number representation system. A system for the representation of numbers; for example, the decimal numeration system, the Roman numeral system, the binary numeration system. *Syn:* **numeration system; numeral system.**

number system. Loosely, a numeration system. [1]

numeral. A representation of a number. *See also:* **binary numeral; decimal numeral; octal numeral; hexadecimal numeral.** [1]

numeral system. *See:* **number representation system.**

numeration. *See:* **number representation.**

numeration system. *See:* **number representation system.**

numeric. Pertaining to numerals, in contrast to letters or other special signs or symbols. *Syn:* **numerical.** [61]

numeric character. *See:* **digit.**

numeric code. A code that uses numerals to represent data.

numerical. *See:* **numeric.**

numerical analysis. The study of methods of obtaining useful quantitative solutions to problems that have been expressed mathematically, including the study of the errors and bounds on errors in obtaining such solutions. [1,60]

numerical shift. *See:* **arithmetic shift.**

nybble (nibble). *See:* **quartet.**

octad (octade). A group of three bits used to represent one octal digit.

octal. (1) Pertaining to a selection in which there are eight possible outcomes. [1]

(2) Pertaining to the numeration system with a radix of eight.

octal digit. A numeral used to represent one of the eight digits in the octal numeration system; 0, 1, 2, 3, 4, 5, 6, or 7.

octal notation. Any notation that uses the octal digits and the radix 8.

octal number. (1) A quantity that is expressed using the octal numeration system.

(2) Loosely, an octal numeral.

octal number system.* *See:* **octal numeration system.**

*Deprecated.

octal numeral. A numeral in the octal numeration system. For example, the octal numeral 14 is equivalent to the decimal numeral 12.

octal numeration system. The numeration system that uses the octal digits and the radix 8. *Syn:* **octal system.**

octal point. The radix point in the octal numeration system.

octal system. *See:* **octal numeration system.**

octal-to-binary conversion. The process of converting an octal numeral to an equivalent binary numeral. For example, octal 213.2 is converted to binary 10001011.01.

octal-to-decimal conversion. The process of converting an octal numeral to an equivalent decimal numeral. For example, octal 213.2 is converted to decimal 139.25.

octet. A group of eight adjacent digits operated upon as a unit.

octodenary. (1) Pertaining to a selection in

which there are 18 possible outcomes.
(2) Pertaining to the numeration system with a radix of 18.

octonary.* *See:* **octal**.

*Deprecated.

odd-even check. *See:* **parity check**.

odd parity. (1) An error detection method in which the number of ones in a binary word, byte, character, or message is maintained as an odd number.

(2) The property possessed by a binary word, byte, character, or message that has an odd number of ones.

ones complement. The diminished-radix complement of a binary numeral, which is formed by subtracting each digit from 1. For example, the ones complement of 1101 is 0010. *Syn:* **complement on one; inverse; inverse binary state**.

operand. A variable, constant, or function upon which an operation is to be performed. For example, in the expression $A = B + 3$, B and 3 are the operands.

operation. The action specified by an operator on one or more operands. For example, in the expression $A = B + 3$, the process of adding B to 3 to obtain the result A .

operation table. A table that describes an arithmetic or logical function by listing all possible combinations of input values and giving the output value that corresponds to each. *See also:* **truth table**.

operator. A mathematical or logical symbol that represents an action to be performed in an operation. For example, in the expression $A = B + 3$, $+$ is the operator, representing addition.

OR. A Boolean operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the OR of P, Q, R, \dots is true if and only if at least one statement is true. *Note:* $P \text{ OR } Q$ is often represented by $P \vee Q$ or $P + Q$. *Syn:* **Boolean add; inclusive OR; disjunction; false add; logic add; log-**

ical add; OR-ELSE; union. *Contrast with:* **exclusive OR**.

\overline{P}	\overline{Q}	$\overline{P \vee Q}$
0	0	0
0	1	1
1	0	1
1	1	1

OR truth table

OR-ELSE. *See:* **OR**.

ordering bias. The manner and degree by which the order of a set departs from random distribution. [67]

ordinary binary. *See:* **binary**.

overflow. (1) The condition that arises when the result of an arithmetic operation exceeds the capacity of the number representation system used in a digital computer.

(2) The carry digit arising from this condition. *Syn:* **arithmetic overflow**.

overflow error. The error caused by an overflow condition in computer arithmetic.

p. Abbreviation for **pico**.

parallel addition. Addition that is performed concurrently on all digit places of the operands. *Note:* This technique uses partial sums and partial carries to obtain its results. *Contrast with:* **serial addition**. [34]

parenthesis-free notation. *See:* **prefix notation**.

parity. (1) An error detection method in which the total number of ones in a binary word, byte, character, or message is set to an odd or even number by appending a redundant bit. This number is subsequently checked to ensure that it remains odd or even.

(2) The property of oddness or evenness possessed by a word, byte, character, or message. This property is determined by the total number of ones.

See also: **even parity; odd parity**.

parity bit. A binary digit appended to a binary word, byte, character, or message to make the

total number of ones an odd or an even number. *See also:* **parity check**.

parity check. A check to determine whether the total number of ones in a binary word, byte, character, or message is odd or even. *Syn:* **even-odd check; odd-even check**.

parity error. The failure of a binary word, byte, character, or message to pass a parity check.

partial carry. (1) A carry process in which the carry digits are stored temporarily, instead of being processed as they occur. *Contrast with:* **complete carry**. *See also:* **cascaded carry; partial sum**.

(2) The numeral that represents the carry digits generated in (1).

partial product. The result obtained by multiplying the multiplicand by one of the digits of the multiplier. *Syn:* **intermediate product**. [61]

partial sum. The result obtained from the addition of two or more numbers without regard to carries. *Note:* In the binary numeration system, the partial sum is the same result as is obtained from the exclusive-OR operation. *See also:* **cascaded carry**. [61]

pico (p). A prefix indicating one billionth (10^{-9}).

place. *See:* **digit place**.

place value. In a positional notation system, the power of the radix that corresponds to a given place. For example, in a decimal integer the place values from right to left are 1, 10, 100, 1000, etc.

point. *See:* **radix point**.

Polish notation. *See:* **prefix notation**.

position. *See:* **digit place**.

positional notation. A number representation system that makes use of an ordered set of digits, such that the value contributed by each digit depends on its position as well as on the digit value. *Syn:* **positional representation**. *See also:* **binary numeration system; binary-coded-decimal system; biquinary nu-**

meration system; decimal numeration system; Gray code. [1]

positional representation. *See:* **positional notation**.

postfix notation. A method of forming mathematical expressions in which each operator is preceded by its operands. For example, A added to B and the result multiplied by C is expressed as $AB + C \times$. *Syn:* **reverse Polish notation; suffix notation**. *Contrast with:* **infix notation; prefix notation**.

precision. The degree of exactness or discrimination with which a quantity is stated. *Contrast with:* **accuracy**.

prefix notation. A parenthesis-free method of forming mathematical expressions devised by the Polish logician Jan Lukasiewicz, in which each operator is immediately followed by its operands. For example, A added to B and the result multiplied by C is expressed as $\times + ABC$. *Syn:* **Lukasiewics notation; parenthesis-free notation; Polish notation**. *Contrast with:* **infix notation; postfix notation**.

primitive Boolean function. A Boolean expression having the property that all other Boolean expressions can be constructed using it alone.

product. The result of a multiplication operation.

propagated error. An error that occurs in a given operation and is passed along to a later operation. *Contrast with:* **inherited error**.

pseudo-random. Pertaining to the approximation of true, statistical randomness.

pseudo-random number. Any member of a sequence of numbers sufficiently close to a random number sequence to permit its use in calculations formally requiring random numbers. [57]

pseudo-random number sequence. A sequence of numbers, determined by some defined arithmetic process, that is sufficiently close to a random number sequence to permit

its use in calculations formally requiring a random number sequence.

pure binary. *See:* **binary.**

pure binary numeration system. *See:* **binary numeration system.**

quantize. To subdivide the range of values of a variable into a finite number of non-overlapping intervals, each of which is represented by an assigned value within the interval. For example, to represent a person's age as a number of whole years.

quartet. A group of four adjacent digits operated upon as a unit. *Syn:* **nibble; nybble.**

quaterdenary. (1) Pertaining to a selection in which there are 14 possible outcomes.
(2) Pertaining to the numeration system with a radix of 14.

quaternary. (1) Pertaining to a selection in which there are four possible outcomes.
(2) Pertaining to the numeration system with a radix of four.

quibinary code. A BCD code in which each decimal digit is represented by a seven-digit binary numeral.

quinary. (1) Pertaining to a selection in which there are five possible outcomes.
(2) Pertaining to the numeration system with a radix of five.

quindenary. (1) Pertaining to a selection in which there are 15 possible outcomes.
(2) Pertaining to the numeration system with a radix of 15.

quintet. A group of five adjacent digits operated upon as a unit.

quotient. The result of a division operation.

radix. A quantity whose successive integer powers are the implicit multipliers of the sequence of digits that represent a number in some positional notation systems. For example, if the radix is 5, then 143.2 means 1 times 5 to the second power, plus 4 times 5 to the first power, plus 3 times 5 to the zero power, plus 2 times

5 to the minus-one power. *Syn:* **base; base number; radix number.** [1]

radix complement. The complement obtained by subtracting each digit of a given numeral from the largest digit in the numeration system, then adding 1 to the least significant digit of the result and executing any required carries. For example, twos complement in binary notation, tens complement in decimal notation. *Syn:* **base complement; complement on n; noughts complement; true complement; zero complement.** *Contrast with:* **diminished-radix complement.**

radix-minus-one complement. *See:* **diminished-radix complement.**

radix notation. A positional representation system in which the ratio of the place values of adjacent digits is a positive integer (the radix). *Syn:* **radix numeration system; radix scale.**

radix number. *See:* **radix.**

radix numeration system. *See:* **radix notation.**

radix point. In positional notation, the character, expressed or implied, that separates the integral part of a numerical expression from the fractional part. For example, binary point, decimal point, hexadecimal point, or octal point. *Syn:* **arithmetic point; base point; point.** [61]

radix scale. *See:* **radix notation.**

random number. A number selected by chance from a given set of numbers, and satisfying one or more of the standard tests for statistical randomness.

random number sequence. (1) A sequence of random numbers, each of which is statistically independent of its predecessors.
(2) Loosely, a pseudo-random number sequence.

real number. A member of the set of all positive and negative numbers, including integers, zero, mixed, fractional, rational, and irrational numbers.

real variable. A variable that may assume only real-number values. [55]

recomplementation. The process of taking the complement of a complement. *Note:* The complement of a complement is the original numeral.

reflected binary code. *See:* Gray code.

reflected binary unit-distance code. *See:* Gray code.

reflected code. *See:* Gray code.

regular binary. *See:* binary.

relative error. The ratio of an error to the correct value. *Contrast with:* **absolute error.** [57]

residual error. The difference between an optimum result derived from experience or experiment and a theoretically exact result.

reverse Polish notation. *See:* postfix notation.

ring shift. *See:* circular shift.

rotate. *See:* circular shift.

round. To delete, or change to zero, the least significant digit or digits of a numeral and to adjust the part retained in accordance with some rule. *Syn:* **round off.**

round down. To round a number, making no adjustment to the numeral that is retained. For example, the decimal numeral 5.6789, when rounded down to two decimal places, becomes 5.67. *Syn:* **truncate** (1).

round off. *See:* round.

round-off error. *See:* rounding error.

round up. To round a number, adjusting the numeral that is retained by adding 1 to its least significant digit and executing any carries required. For example, the decimal numeral 5.6789 when rounded up to two decimal places becomes 5.68.

rounding error. The error introduced by rounding a number. *Syn:* **round-off error.**

row binary. Pertaining to the binary representation of data in which adjacent positions in a row correspond to adjacent binary digits. For example, each row in an 80-column card may be used to represent 80 consecutive bits of a binary word. *Contrast with:* **column binary.**

scalar. A quantity containing a single value, as distinguished from a vector, matrix, etcetera.

scale. To multiply the representation of a number by a factor in order to bring its range within prescribed limits.

scale factor. A number used as a factor in a scaling operation. *See also:* **scale.**

scientific notation. A notation system in which a number is expressed as a coefficient multiplied by a power of ten.

self-checking code. *See:* error detecting code.

self-complementing code. A binary code in which the complement of each decimal digit represented equals the complement of its binary representation. *See also:* **excess-three code.**

senary. (1) Pertaining to a selection in which there are six possible outcomes.

(2) Pertaining to the numeration system with a radix of 6.

septenary. (1) Pertaining to a selection in which there are seven possible outcomes.

(2) Pertaining to the numeration system with a radix of 7.

septendecimal. (1) Pertaining to a selection in which there are 17 possible outcomes.

(2) Pertaining to the numeration system with a radix of 17.

septet. A group of seven adjacent digits operated upon as a unit.

serial addition. Addition that is performed by adding the corresponding digits of the operands, one digit place at a time. *Contrast with:* **parallel addition.**

sexadecimal. *See:* **hexadecimal.**

sexagenary. (1) Pertaining to a selection in which there are 60 possible outcomes.
(2) Pertaining to the numeration system with a radix of 60. *Syn:* **sexagesimal.**

sexagesimal. *See:* **sexagenary.**

sextet. A group of six adjacent digits operated upon as a unit.

Sheffer stroke. *See:* **NAND.**

Sheffer stroke function. *See:* **NAND operation.**

shift. A displacement of an ordered set of characters one or more places to the left or right. If the characters are the digits of a numeral, a shift may be equivalent to multiplying by a power of the base. *See also:* **arithmetic shift; logical shift.** [1]

sideways sum. A sum obtained by adding the digits of a numeral without regard to position or significance. *See also:* **check sum.** [61]

sign bit. A binary digit used to indicate the algebraic sign of a number.

sign digit. A character used to represent the algebraic sign of a number.

sign-magnitude arithmetic. Computer arithmetic using numerals expressed in sign-magnitude notation. *Syn:* **signed binary arithmetic.**

sign-magnitude notation. A numeration system in which the left-most bit is interpreted as the sign bit and the remaining bits represent the magnitude. *Contrast with:* **twos-complement notation.**

sign position. The position at which the sign of a number is located. [1]

signal distance. *See:* **Hamming distance.**

signed binary arithmetic. *See:* **sign-magnitude arithmetic.**

significance. *See:* **weight.**

significand. The component of a floating-point number that consists of an explicit or implicit leading digit to the left of its implied radix point and a fraction field to the right. *Syn:* **fixed-point part; mantissa.** *Contrast with:* **exponent (2).**

significant digit. A digit that contributes to the accuracy or precision of a numeral. *See also:* **least significant digit; most significant digit.** [1]

significant figure.* *See:* **significant digit.**
*Deprecated.

significant-digit arithmetic. A method of making calculations using a modified form of floating-point representation in which the number of significant digits in the result is determined by the number of significant digits in the operands, the operations performed, and the degree of precision available.

single precision. Pertaining to the use of a single computer word to represent a number. *Note:* Single precision is implied in number representation and in computer arithmetic unless multiple precision is specified.

smooth. To apply procedures that decrease or eliminate rapid fluctuations in data. [67]

special addition.* *See:* **double-precision addition.**
*Deprecated.

standard binary. *See:* **binary.**

standardize. *See:* **normalize.**

standing-on-nines carry. A carry process in which a carry digit transferred to a given digit place is further transferred to the next higher digit place if the current sum in the given digit place is nine.

stochastic. Pertaining to variables that are probabilistic in nature.

straight binary. *See:* **binary.**

subnormal number. A non-zero floating-point number whose exponent is the precision's

minimum and whose leading significant digit is zero. [125]

subtrahend. A number to be subtracted from another number (the minuend) to produce a result (the difference).

suffix notation. *See:* **postfix notation.**

sum. The result of an addition operation.

sum check. *See:* **summation check.**

summation check. A check in which a group of digits is summed, usually without regard to overflow, and that sum is checked against a previously computed value to verify that no digits have been changed. *Syn:* **sum check.**

switching function. A function that has only a finite number of possible values and whose independent variables each have only a finite number of possible values. [34]

switching variable. A variable that may take only a finite number of possible values or states. *Syn:* **logical variable.** [34]

symbol rank. *See:* **digit place.**

table look-up. A procedure for obtaining the value of a function corresponding to a given argument from a table of function values. *See also:* **look-up table.**

tens complement. The radix complement of a decimal numeral, which may be formed by subtracting each digit from 9, then adding 1 to the least significant digit and executing any required carries. For example, the tens complement of 4830 is 5170. *Syn:* **complement on ten.**

terdenary. (1) Pertaining to a selection in which there are 13 possible outcomes.
(2) Pertaining to the numeration system with a radix of 13.

ternary. (1) Pertaining to a selection in which there are three possible outcomes. [1]
(2) Pertaining to the numeration system with a radix of 3. [1]

ternary incremental representation. Repre-

sentation of changes in variables in which the value of an increment is plus one, zero, or minus one. *Syn:* **incremental ternary representation.**

tetrad. A group of four closely related items or digits.

threshold. (1) A logic operator having the property that if P is a statement, Q is a statement, R is a statement,..., then the threshold of P,Q,R,... is true if at least N statements are true, false if less than N statements are true, where N is a specified non-negative integer called the threshold condition. [1,67]
(2) The threshold condition as in (1). [1,67]

triad. A group of three closely related items or digits.

triple precision. Pertaining to the use of three computer words to represent a number in order to preserve or gain precision.

triple-precision arithmetic. Computer arithmetic performed with operands that are expressed in triple-precision representation.

triplet. A group of three adjacent digits operated upon as a unit.

true complement. *See:* **radix complement.**

truncate. (1) *See:* **round down.**
(2) To terminate a computational process in accordance with some rule; for example, to end the evaluation of a power series at a specified term. [1]

truncation error. An error caused by truncation.

truth function. A function that may take one of two possible values: true or false.

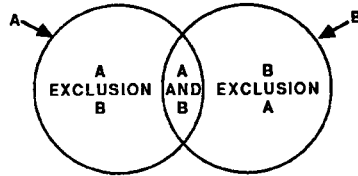
truth table. An operation table that describes a truth function by listing all possible combinations of input values and giving the corresponding output values. *Syn:* **Boolean operation table.** *See also:* **AND; NOT; OR.**

two-out-of-five code. A BCD code in which each decimal digit is represented by a five-bit numeral of which two bits are in one state (usu-

- ally ones) and three are in the other state. *See also: m-out-of-n code.*
- two-scale.** *See: binary notation.*
- two-state variable.** *See: binary variable.*
- two-valued variable.** *See: binary variable.*
- twos complement.** The radix complement of a binary numeral, which may be formed by subtracting each digit from 1, then adding 1 to the least significant digit and executing any required carries. For example, the twos complement of 1101 is 0011. *Syn: complement on two.*
- twos-complement arithmetic.** Computer arithmetic performed with operands that are expressed in twos-complement notation.
- twos-complement notation.** A binary numeration system in which negative numbers are represented by their twos complement and positive numbers are expressed in their usual binary form. *Contrast with: sign-magnitude notation.*
- unary operation.** *See: monadic operation.*
- unary operator.** *See: monadic operator.*
- unbalanced error.** (1) A set of error values in which the maximum and minimum are not necessarily opposite in sign and equal in magnitude. [61]
(2) A set of error values whose average is not zero.
Contrast with: balanced error.
- unbiased rounding.** A rounding process in which the rules for adjusting the retained numeral ensure that the average rounding error is zero.
- uncertainty.** The upper bound on an absolute error or relative error. [2]
- underflow.** The condition that arises when the result of a floating-point arithmetic operation is smaller than the smallest non-zero number that can be represented in a digital computer. *Syn: arithmetic underflow.*
- underflow error.** The error caused by an underflow condition in computer arithmetic.
- uniform random number.** Any member of a random number sequence that has a uniform statistical distribution.
- union.** *See: OR.*
- unit-distance code.** A code in which the Hamming distance between consecutive numerals is 1. *Syn: continuous-progression code; cyclic permuted code.*
- unitary code.** A code having only one digit; the number of times it is repeated determines the quantity it represents. [60]
- units position.** In a positional notation system, the position corresponding to the zero power of the radix. This is the right-most position in a numeral representing an integer.
- unodecimal.** (1) Pertaining to a selection in which there are 11 possible outcomes.
(2) Pertaining to the numeration system with a radix of 11.
- USA Standard Code for Information Interchange (USASCII).*** *See: American National Standard Code for Information Interchange (ASCII).*
*Deprecated.
- USASCII.*** Acronym for USA Standard Code for Information Interchange. *See: American National Standard Code for Information Interchange (ASCII).*
*Deprecated.
- variable point.** Pertaining to a numeration system in which the position of the radix point is indicated by a special character at that position. *Contrast with: fixed point; floating point.* [1]
- Veitch chart.** *See: Veitch diagram.*
- Veitch diagram.** A variation of the Karnaugh map in which the rows and columns are headed with combinations of the variables in a straight binary sequence. *Syn: Veitch chart; Veitch-Karnaugh diagram.*

Veitch-Karnaugh diagram. *See:* Veitch diagram.

Venn diagram. A diagram in which sets are represented by closed regions. [1]



Example of a Venn Diagram

vicenary. (1) Pertaining to a selection in which there are 20 possible outcomes.
(2) Pertaining to the numeration system with a radix of 20.

weight. In positional representation of numbers, the value of a given digit position. *Syn:* **significance.**

word. A sequence of bits or characters that is stored, addressed, transmitted, and operated on as a unit within a given computer. *Syn:* **computer word; machine word.**

XNOR. Acronym for **exclusive NOR.**

XOR. Acronym for **exclusive OR.**

zero complement. *See:* **radix complement.**

zero compression. *See:* **zero suppression.**

zero elimination. *See:* **zero suppression.**

zero fill. To fill the digit positions of a storage medium with the representation of the character zero. *Syn:* **zeroize.**

zero proof. A method of checking computations by adding positive and negative values so that if all computations are accurate the total will be zero.

zero suppression. The elimination of zeros that have no significance or use, such as zeros to the left of the integral part of a numeral or zeros to the right of the fractional part. *Syn:* **zero compression; zero elimination.**

zeroize. *See:* **zero fill.**

5. Dictionary Resources

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